# The influence of protective varnish on the integrity of orthodontic cements

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**Objective:** The aim of the present study was to assess the influence of saliva contamination over the structural strength and integrity of conventional glass-ionomer cements used for cementing orthodontic bands in the absence and presence of a surface-protecting varnish. **Method:** 48 samples were prepared by inserting 3 types of glass-ionomer cements into standardized metallic matrixes of 10 mm of diameter and 2 mm of depth. The cements used were: Meron (VOCO), Ketac-Cem (3M ESPE) and Vidrion C (DFL), all of which comprised groups A, B and C, respectively. Subgroups A1, B1 and C1 comprised samples with no surface protection, whereas subgroups A2, B2 and C2 comprised samples of which surface was coated with Cavitine varnish (SS White), after cement manipulation and application, in order to protect the cement applied. All samples were stored in artificial saliva for 24 hours at 37°C. A Vickers diamond micro-durometer was used to produce indentations on the non-treated group (non-varnished) and the treated group (varnished). **Results:** Varnished materials had significantly higher microhardness values in comparison to non-varnished materials. Ketac-Cem had the highest microhardness value among the varnished materials. **Conclusion:** Varnish application is necessary to preserve the cement and avoid enamel decalcification. Glass-ionomer cements should be protected in order to fully keep their properties, thus, contributing to dental health during orthodontic treatment.

**Keywords:** Glass-ionomer cements. Artificial saliva. Microhardness.

**Objetivo:** avaliar a influência da contaminação salivar na resistência estrutural e integridade de cimentos de ionômero de vidro convencionais utilizados para cimentação de bandas ortodônticas na ausência e na presença de um verniz protetor de superfície. **Métodos:** quarenta e oito corpos de prova foram confeccionados a partir de três cimentos ortodônticos, com auxílio de matrizes metálicas padronizadas com 10mm de diâmetro e 2mm de altura. Os cimentos utilizados foram: Meron (Voco), Ketac-Cem (3M ESPE) e Vidrion C (DFL), compondo os grupos A, B e C, respectivamente. Metade dessas amostras não recebeu nenhum tipo de proteção superficial, constituindo os subgrupos A1, B1 e C1, enquanto, os subgrupos A2, B2 e C2 tiveram suas superfícies isoladas com verniz Cavitine (SS White) após manipulação e aplicação do cimento, com intuito de proteger a superfície do cimento. As amostras foram armazenadas em saliva artificial por 24 horas a 37°C. Foi realizado um ensaio de microdureza (Vickers) para avaliação da dureza de superfície do grupo não-tratado (sem isolamento) e do grupo tratado (agente protetor). **Resultados:** os materiais previamente isolados com o verniz obtiveram valores de microdureza significativamente maiores que os não-isolados. O cimento Ketac-Cem apresentou, estatisticamente, a maior microdureza entre os materiais protegidos. **Conclusão:** o isolamento com verniz mostrou-se necessário para preservação do cimento e, consequentemente, de sua capacidade de evitar possíveis desmineralizações dentárias. Os cimentos de ionômero de vidro devem ser protegidos para manutenção de sua integridade, contribuindo para saúde dental durante o tratamento ortodôntico.

**Palavras-chave:** Cimentos ortodônticos. Saliva artificial. Microdureza.

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## INTRODUCTION

Maintaining an adequate oral health is a constant challenge in Orthodontics, since the high number of retentive surfaces present in the orthodontic appliances hinders bacterial plaque removal. Some issues involving attachment material, such as poor sealing, inadequate structural and adhesive strength as well as cement solubility in oral fluids contribute to enamel decalcification.[1,2,3]

Failure in band cementation usually results in serious problems for orthodontic treatment. If any failure in cement seal occurring between the band and the tooth is not immediately detected, enamel demineralization may occur at the margins of the band.[4] In addition to attaching the bands, the cement protects the banded tooth against cavity. The resistance of these dental cements to oral fluids can be measured by their solubility and disintegration.[5]

Glass-ionomer cement is a generic denomination for a group of materials produced by the reaction between silicate glass powder and polyacrylic acid.[6] The main characteristics of this material are fluoride release, important for enamel remineralization of carious teeth, biocompatibility, and adhesion to the enamel, which occurs by chemical attraction between the apatite and the polyacrylic acid.[7]

Due to its capacity of adhering to the dental structure and its ability to release fluoride ions, the glass-ionomer cement is indicated not only for preventive restorations, but also as a filling and attaching material.[6] In addition, glass-ionomer cement can adhere to stainless steel, which favors its use as an attaching material.[8]

Bands attached with glass-ionomer cement require less recementations, present less decalcification in the surrounding enamel, and show higher amount of remnant cement after debonding.[9] On the other hand, the glass-ionomer cement has the disadvantage of being susceptible to humidity.[10]

During the initial curing phase of the glass-ionomer cement, any contamination can adversely affect its surface hardness, thus, altering its properties.[11,12] In clinical cases in which contamination control is difficult, its use is contra-indicated.[13] For this reason, it seems to be reasonable to isolate the glass-ionomer cement from the oral environment with impermeable materials during initial curing in order to avoid any undesired changes.

There are several studies in the literature relating materials and their adhesive capacity, particularly using composites and hybrid ionomers on shear bond tests,[14] in addition to those that emphasize bond strength and ts failures.[9,15,16] Other studies have correlated the fluoride-releasing ability of certain materials with their cariostatic effects.[3,9] However, no studies have been carried out on the need for isolating conventional glass-ionomer cements surfaces during cementation of orthodontic bands, even though this action is essential for the preservation and longevity of this type of cement in restorative Dentistry practice.[17]

In this study, Cavitine varnish was chosen for such protection. According to the manufacturer, it is a nitrocellulose-based (8%) varnish with some unique features, including excipients (ethyl acetate, ethanol) which cause it to be volatile and fast-drying. It is used as cavity liner and for protection of silicate restorations, since it prevents salivary action and avoids moisture during crucial reaction steps.

Microhardness is among the properties which may be affected by contamination during the initial curing phase. Surface microhardness is defined as being the microstructure and texture activities of a given material, which are used for predicting material strength as well as its ability of abrading opposite structures.[18] It is, in fact, one of the most important mechanical properties for comparative studies of dental materials.[11] Strength, curing time and erosion of the glass-ionomer cement have evolved as new hardness tests are performed.[19] Knowing the material surface microhardness behavior is crucial when choosing the best material, since this property changes when it is exposed to humidity — condition that is similar to that of the oral cavity.[18]

Therefore, the objective of the present study was to assess the effects of varnish isolation on microhardness of conventional glass-ionomer cements in the presence of salivary contamination during initial curing phase.

## MATERIAL AND METHODS

In the present study, conventional glass-ionomer cements were assessed. They were manipulated according to the manufacturer's instructions and only one investigator tested the materials.

Three conventional glass-ionomer cements commonly available on the market were used, namely: Group A (Meron, VOCO, Cuxhaven, Germany, batch 109012051); Group B (Ketac-Cem, 3M ESPE, Seefeld, Germany, batch 221924); and Group C (Vidrion C, DFL, Rio de Janeiro, Brazil, batch 0060406 — powder, batch 0010106 — liquid). Each group was divided into two subgroups containing 8 samples each (Subgroups A1, A2, B1, B2, C1, and C2), in which number 1 refers to those samples without isolation after manipulation and application of the cement, and number 2 refers to those samples receiving protection against humidity. A total of 48 samples was obtained and humidity protection was achieved by means of applying Cavitine varnish (SS White, Rio de Janeiro, Brazil, batch 013) onto the cement surfaces.

The samples were obtained by inserting the materials into standardized metallic matrixes of 10 mm in diameter and 2 mm in depth. Insertion was performed by using Centrix syringe (DFL) in order to avoid air bubbles. A glass plate was put onto the matrixes so that a plane surface could be obtained, thus, preserving the surface layer as well as enabling the focus during microhardness test.

After the initial 10 minutes, all samples were immersed into artificial saliva, including those from subgroups A2, B2, and C2 which had been coated with Cavitine varnish by using microbrushes (Cavibrush – FGM). The material was kept in a stove at 37°C for 24 hours.[17]

All samples were kept under moist conditions in order to avoid dehydration and test the varnish efficiency. Artificial saliva was chosen because it increases surface hardness of glass-ionomer cements and simulates the conditions found within the oral environment, which would not happen if distilled water was used.[19]

The microhardness tests were performed by using a Vickers diamond microdurometer (E. LEITZ, Germany) with a 100 gf load being applied during 30 seconds in order to produce indentations, which were measured in Vickers hardness (HV). Five indentations were performed in each sample of each group, with a total of 80 indentations — 40 in varnish-coated samples and 40 in non-varnished ones. The microhardness values were obtained by measuring the diagonal of the imprints magnified by 50 times with ZoomMagic 2.0 software (PeakStar, USA). The results were calculated with the following formula: $HV = 1854.4\, P/d^2$, where P = indentation load and d = diagonal obtained.[11]

Analysis of variance was employed to compare all the subgroups, whereas Tukey's test was used for multiple comparisons. The significance level was set at 1%.

## RESULTS

Table 1 and Figure 1 show the microhardness values obtained for all subgroups. They demonstrate that varnish-coated samples had higher microhardness values in comparison to the non-varnished ones ($P < 0.01$). Ketac-Cem glass-ionomer cement (3M ESPE), either varnished or non-varnished, had the highest microhardness value after being stored in artificial saliva for 24 hours.

The varnish-coated samples were found to have smoother and more regular surfaces (Fig 2), as well as the highest microhardness values. On the other hand, cracks and rugosities were observed in the non-varnished samples which also presented inappropriate microhardness values (Fig 3).

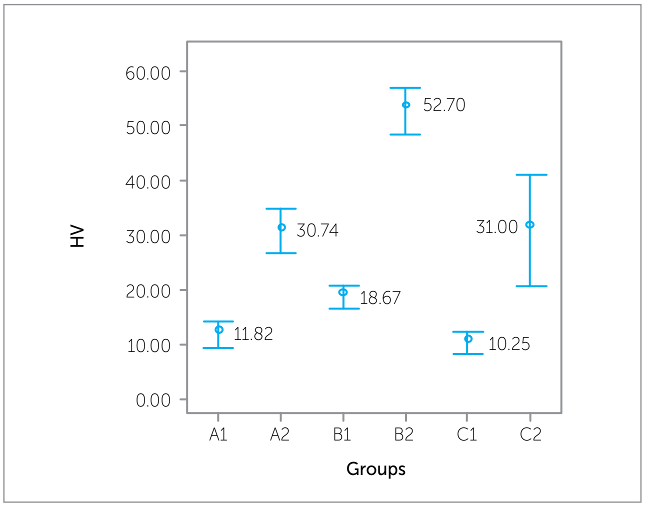


**Figure 1** - Graphic representation of microhardness differences found for each subgroup.

**Table 1** - Vickers microhardness values (kg/mm²) for different subgroups (mean ± standard deviation).

| Group A (Meron, Voco) | | Group B (Ketac-Cem, 3M ESPE) | | Group C (Vidrion, DFL) | |
|---|---|---|---|---|---|
| A1[c] | A2[b] | B1[c] | B2[a] | C1[c] | C2[b] |
| HV = 11.82 ± 2.73 | HV = 30.74 ± 4.88 | HV = 18.67 ± 1.74 | HV = 52.69 ± 4.27 | HV = 10.24 ± 2.39 | HV = 31.00 ± 12.21 |

Superscribed letters indicate statistically significant differences ($P < 0.01$) for a>b>c.

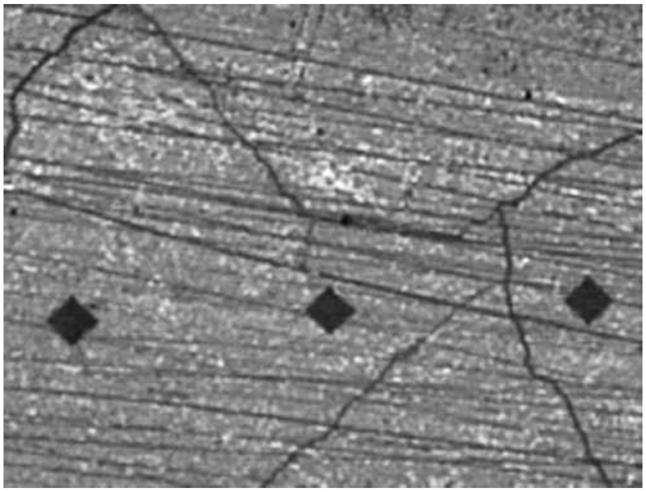

Figure 2 - Subgroup B1 sample surface (non-varnished). Presence of cracks, fissures, and large indentations . 50 times magnification.

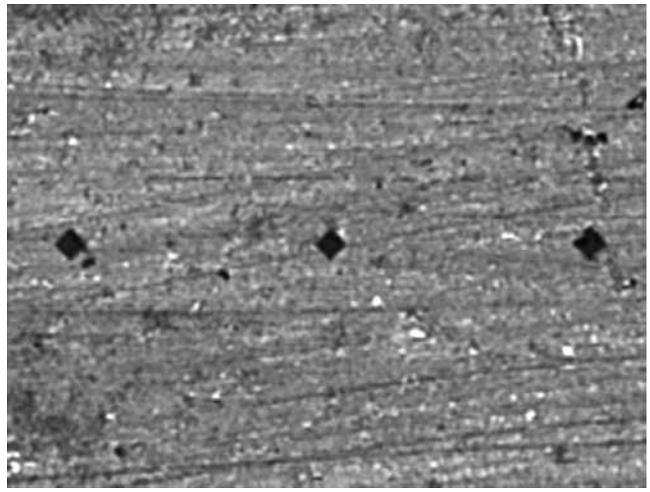

Figure 3 - Subgroup B2 sample surface (varnished). Smooth surface with small indentations. 50 times magnification.

## DISCUSSION

Mechanical properties of materials are intimately related to their overall quality and integrity. Material's surface degradation is associated with an increase in rugosity and allows bacteria lodging and, as a consequence, causes undesirable tissue reactions. This explains the need for materials to preserve their mechanical properties, specially hardness.[20,21] Materials with better microhardness are more likely to withstand saliva biochemistry, constant pH variations, different temperatures and, specially, the resident oral microbiome.[22] This is the reason why the present study aimed at verifying surface behavior of 3 types of conventional glass-ionomer cements with regard to humidity and varnish-protection effects. Therefore, the methodology chosen has proved to be adequate.[17]

In the present study, a 10-minute curing time was adopted before saliva contamination, as stated in previous studies.[11,18] The curing time for conventional glass-ionomer cements ranges between 4.4 and 12.2 minutes.[23] The first 10 minutes of chemical reaction are the most important, since acid attack occurs during this period of time, thus, resulting in ion release (fluoride, sodium, calcium, aluminum, and phosphate).[24] Dehydration was also avoided in the first 10 minutes of chemical reaction by means of using glass plates on the samples, which prevented direct contact between the material and the air, in addition to making the surfaces smooth and uniform.

Total surface hardness of glass-ionomer cements is achieved nearly 24 hours after application and the testing procedures are usually carried out within this period of time to investigate the effects of storage on the cement properties.[23,25,26] As glass-ionomer cement is susceptible to humidity, it is recommended that its surface be coated during the initial curing phase, that is, soon after loosing its surface brightness.[10,18] However, glass-ionomer cements have a slow curing process and during this phase, they are susceptible to saliva and water attacks, which dissolve such materials.[27]

Water plays a crucial role during the curing phase of glass-ionomer cements. First, it serves as a reaction medium and then it slowly hydrates the cross-linked matrix, allowing formation of a stable gel structure which is more resistant and also less susceptible to humidity. If the newly-used cement is exposed to the environment with no protective layer, its surface will show cracks and fissures caused by dehydration. Both dehydration and excess humidity can damage the integrity of the material.[26,28]

If no protection is provided, the material surface will inevitably become porous and cracked, as observed in the non-varnished samples (subgroups A1, B1 and C1). This result can be explained by the nature of the material, because glass-ionomer cements, even when reinforced with composites, react in a more sensitive manner to moistness and abrasion.[29]

Since water balance is crucial to form a stable matrix, and, consequently, to cement maturation, surface protection is extremely important during the initial setting. Thus, due to the fact that glass-ionomer cements exhibit a high degree of solubility and disintegration in the oral environment, protecting the material surface, characterized by its rugosity, is essential to prevent degradation and avoid *S. mutans* colonization.[17,30]

Protecting the surface of glass-ionomer cement is a process that lasts for at least 1 hour, although the ideal time required to increase resistance to disintegration is 24 hours.[31] It is known, however, that in the oral environment, protective materials are lost within the first 24 hours because of friction.[17] That is the reason why in the methodology used for this study, Cavitine varnish was able to protect the surfaces of the materials within 24 hours.

Although varnishes are indicated as surface protection materials for cements,[13,32] there are reports in the literature in which the evaporation of the varnish solvent is associated with protective films with faulty lines, which does not ensure adequate protection.[17] On the other hand, according to the manufacturer's specifications and the results of this study, Cavitine varnish can be used in orthodontic practice. That is because it proved to be efficient with regard to protection, specially for cementation, since only a small amount of material is actually exposed to the oral environment when a correct adaptation of the band is achieved.

Subgroups A2, B2, and C2 (varnished with Cavitine) had the highest microhardness values. Among the commercially available materials assessed, Ketak-Cem proved to have the highest microhardness values, as previously observed.[33] Additionally, no statistically significant differences were observed in the microhardness values of the non-varnished samples. Therefore, surface protection of glass-ionomer cements during the initial curing phase was found to be useful.

Considering the complexity of the oral environment, preserving the integrity of the material is necessary,[30] since failures in cement bands may lead to tooth demineralization and delay treatment due to the need for recementation. Selecting appropriate materials and caring for their preservation is of professional responsibility, in view of the longevity of orthodontic treatments and commitment to patient health.

## CONCLUSION

Protecting the surface of glass-ionomer cements with varnish during the initial curing phase promoted higher microhardness values 24 hours after its application, corroborating the fact that adequate cement preservation is necessary to avoid enamel decalcification. In addition, further clinical comparative studies are required to assess orthodontic bands cemented with either varnished or non-varnished glass-ionomer cements.

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